10.3 SUBTROPICAL MIDDLE ATMOSPHERE DYNAMICS OBSERVED BY THE CHUNG LI RADAR

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ABSTRACT

The Chung Li radar (24.91°N; 121.24°E) has been operating since 1986. A five-beam observational configuration has been used on a regular basis to study the various dynamics processes in the atmosphere-lower stratosphere height region. Due to its geographical location, the annual Typhoon and Mei-Yu seasons provide good opportunities to study the various interesting dynamic processes such as instabilities, generation of gravity waves, wave-mean field interaction, etc. Three-dimensional air motions due to these fronts will be presented. Special cases of gravity wave generation, propagation and their effects on the turbulent layers will be discussed.

INTRODUCTION

The Chung Li VHF radar is located in the northern part of Taiwan. Since late 1986, it has been in full operation. The radar is situated approximately 50 km southwest of Taipei. The geographical position of the radar is 24.91°N; 121.24°E. It is in the subtropical region. There are several interesting annual meteorological phenomena that are special in this area. There is the Mei-Yu season that usually occurs during the months of May and early June. The Typhoon season starts about July and lasts until approximately the end of September. The Chung Li radar is in the position to observe some of the dynamical behavior of the upper troposphere and lower stratosphere in this interesting region. In this paper, some of the results based on the data base for the past year or so will be presented.

Table 1 summarizes the parameters for the Chung Li radar.

TABLE 1. Chung Li Radar.

Frequency	52 MHz
Average Power	4 kW
Duty Cycle	2%
Minimum Pulse	1μs
Antenna	3 phased arrays, 64 Yagi each
Beam Positions	Vertical and 4 oblique at 17°

POSITION OF TROPOPAUSE IN THE SUBTROPICAL REGION

With the radar beam pointed upward, the position of the tropopause can be determined using the procedure developed by Gage and Green [1979]. Figure 1 shows the long-term behavior of the tropopause heights at Chung Li.

HUMIDITY CONTRIBUTIONS TO ECHO POWER -- EFFECTS OF TYPHOON

Because the Chung Li radar is on a subtropical island, it is expected that humidity in the troposphere will play a very important role in providing echo returns of the radar signals. Indeed, from the very beginning of Chung Li operation, it has been noticed that echo power decreases sharply above 7 or 8 km. Since radiosonde data are available at Chung Li either on site or at a distance approximately 30 km away, it is possible to model the "dry" term and "wet" term contributions to the echo power [Gage and Balsley, 1980; Röttger, 1984]. Figure 2 shows such a

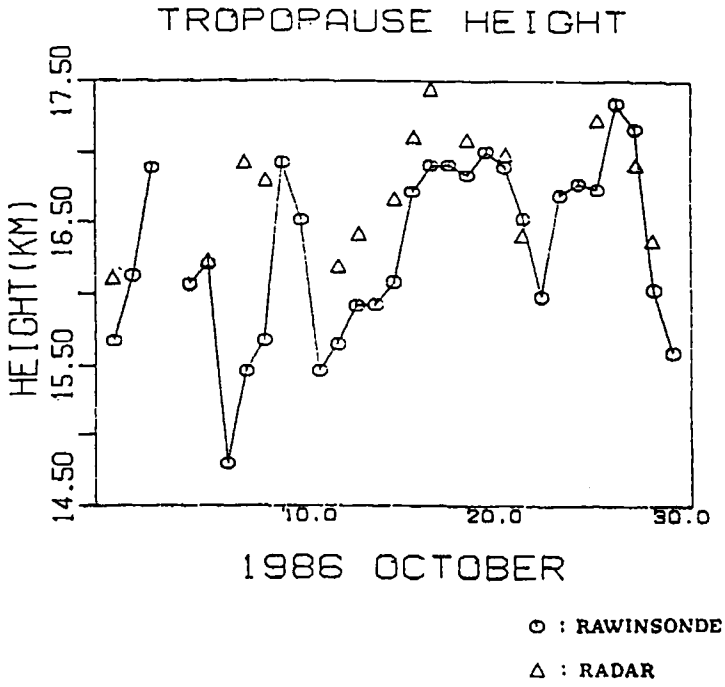

Figure 1.

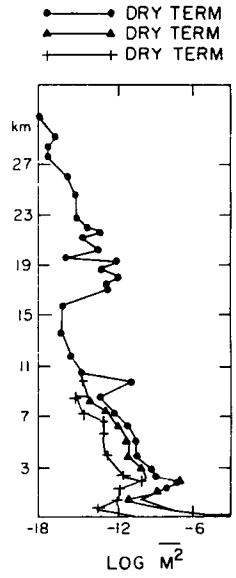

Figure 2.

model. It is apparent that the contribution from humidity dominates in the height region from 2 to 8 km. This is quite different from the usual reflectivity profile where temperature fluctuations dominate above 4 ~ 5 km [Gage and Balsley, 1980; Röttger, 1984].

Another interesting phenomenon observed at Chung Li is that whenever there is a Typhoon passing through, or near the Island, the VHF radar gets echoes from higher range gates, sometimes up to 4 range gates at 300 m height resolution. Figure 3 shows such an example. This perhaps is due to the fact that the Typhoon has caused the uplift of the humid air from the lower height which in turn contributes to the enhanced echo power.

SPECTRA OF VELOCITY FLUCTUATIONS

The Chung Li radar can be used for 5-beam observations of the atmospheric dynamics. The experimental setup will be for beam 1 to be upward, beams 2 and 4 oblique at 17° east and west, respective, beams 3 and 5 oblique at 17° north and south, respectively. Spectra of velocity fluctuations at each beam are computed. Figure 4 shows the results of such an experiment. The spectra from the four oblique beams are quite similar and are shown as averaged spectra. Using the procedure developed by Scheffler and Liu [1985], a model gravity wave spectrum can be found that fits the observed oblique spectra quite well. Using these parameters it is possible to predict the vertical spectrum if the observed velocity fluctuations are entirely due to gravity waves. This predicted spectrum can then be compared with the observed spectrum. Figure 4b shows such a comparison. There is reasonable agreement between the two spectra, especially the level and the shape. The weather conditions for this data set are in general quiet. Similar observations were carried out during a more active situation. This was during the period of the passage of the Mei-Yu front. Figure 4c shows the averaged spectra for the oblique beams. When a gravity wave model was used to transfer the oblique spectra to vertical spectra and compared with observed spectra, much greater discrepancies were found. Figure 4d shows the comparison. The predicated spectra are about an order of magnitude higher than the observed ones, indicating that on these oblique beams there probably are contributions to the velocity fluctuations other than gravity waves.

CONCLUSION

In this paper, results from the Chung Li radar are presented giving examples on the special features in this subtropical upper atmosphere observed by the radar. More statistical analysis on the data accumulated are being carried out and will be communicated in the near future.

ACKNOWLEDGMENT

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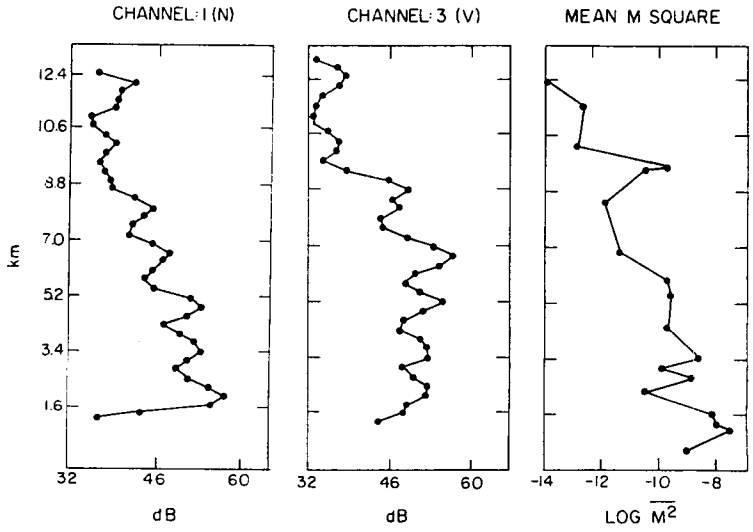

Figure 3.

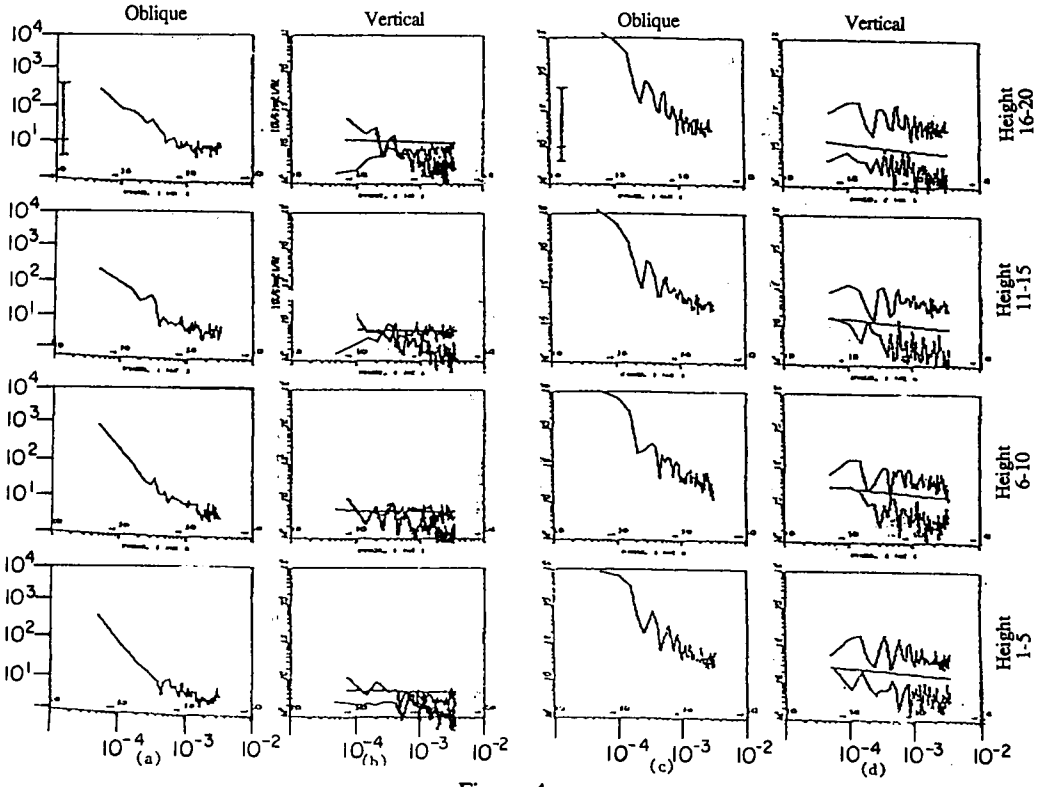

Figure 4.